Rethinking Electricity Sector Reform in Developing Asia:

Balancing Economic and Environmental Objectives

Anupama Sen, Rabindra Nepal, Tooraj Jamasb

Abstract

The OECD or 'standard' model of electricity sector reforms has been widely adopted in non-OECD Asian countries since the 1990s. However, despite two decades of attempts at reforms, no notable progress has been made towards the original objectives of reform. Whilst in OECD countries, reforms were implemented against excess capacity and stable institutions, in developing non-OECD Asian countries they were implemented against chronic electricity shortages, fiscal constraints, weak institutions, and complex political factors. In recent years the debate also focuses on the suitability of electricity market reforms originally designed around fossil fuels in delivering low carbon electricity systems. With electricity demand set to double over the next two decades, reforms in non-OECD Asian countries have important economic as well as environmental implications in terms of global energy use and emissions. This chapter assesses the application of the OECD model of electricity reform in Asia. We analyse the experience of three South Asian countries – India, Nepal and Bhutan, to illustrate the economic and environmental conflicts in electricity market reform against the context of cross-border regional electricity trade.

JEL Codes: L94; Q58; R58

Keywords: market liberalisation; electricity restructuring; environment

Authors

Tooraj Jamasb, Durham Business School, Mill Hill Lane Durham DH1 3LB, United Kingdom, Tel: +44 (0)191 33 45463, Email: tooraj.jamasb@durham.ac.uk

Anupama Sen, Oxford Institute for Energy Studies, U.K. 57 Woodstock Road, Oxford OX2 6FA, United Kingdom. Tel: +44 (0)1865 311 377 Email: anupama.sen@oxfordenergy.org

Rabindra Nepal, CDU Business School, Charles Darwin University, Australia. Tel: +61 (0) 889468856 Email: rabindra.nepal@cdu.edu.au

An alternative Version of this Working Paper is forthcoming as a chapter in Bhattacharya, S. (Ed.) Handbook of Energy in Asia, Routledge (forthcoming, 2017).

1. Introduction

Many of the electricity reform programmes currently being undertaken across developing economies in non-OECD Asia originated in the experiences of a group of OECD countries in the 1980s and 1990s.[1] These were, primarily, the United Kingdom (England and Wales), Norway, the USA, and Chile – often highlighted as forerunners (Pollitt, 2004). Reform entailed restructuring the sector from a scenario characterised by state-owned, vertically integrated entities, into one where smaller, and in most cases privately-owned firms, competed for the provision of electricity supplies (Sen et al, 2016). From these experiences emerged a raft of basic reform measures or 'blueprint', which included:

- opening the electricity sector to Independent Power Producers (IPPs),[2]
- corporatization [3] of vertically integrated state-owned utilities and the commercialization of their functions,
- enactment of electricity legislation,
- establishment of an independent electricity regulator,
- unbundling of vertically integrated utilities into competitive (generation and supply) and regulated (transmission and distribution) segments, and
- divestiture or privatization of the unbundled utilities.

Collectively, these measures came to be known as the 'standard model' of electricity reform.[4] Wholesale markets featured prominently in the details of the standard model, as did retail competition and consumer choice. The standard model was based on the

[1] Some of the arguments in this chapter were first developed in a working paper: Sen, A. (2014).'Divergent Paths to a Common Goal: An Overview of Challenges to Electricity Sector Reform in Developing versus Developed Countries', *EL10, Oxford Institute for Energy Studies.*

[2]Privately owned electricity generation companies which produce electricity for sale to utilities.

[3]The creation of separate legal entities.

[4]Also the 'textbook' or 'prescriptive' approach (Gratwick and Eberhard, 2008; Joskow, 2008; Victor and Heller, 2007).

implicit assumptions of well-functioning markets, developed institutions, and stable political frameworks found in developed countries.

Although the arguments in favor of electricity market reform via the OECD model primarily focused on its economic benefits,[5] the literature presents mixed evidence on whether the predominant drivers behind initial reform, particularly in the UK, were purely economic, or ideological (Newbery, 2013; Rutledge, 2010; Helm, 2010; Keay, 2009).[6] It has been suggested that the economic rationale for market liberalization evolved *ex post* and was secondary to ideological and political considerations (Rutledge, 2010)[7].

Evidence on the success of reforms in developed economies is mixed; the literature suggests that it is difficult to attribute the improvements in operational efficiency to reform *per se* when there has been a combination of external factors.[8] There is a vast literature documenting the early experience of reforms in developed countries (Sen, 2014).[9] However, growing environmental pressures and international consensus towards climate change mitigation since 2009[10], have prompted fresh debates over the effectiveness and the mission of electricity reforms, as decarbonisation has been incorporated into reforms as an important environmental objective. This is because

[5]Specifically pertaining to improvements in the efficiency of operation of utilities brought about by greater competition, which could then be passed on to consumers through competitive (potentially lower) prices and better quality of service.

[6]For instance, the political factors underpinning electricity reform in the UK included weakening the power of the coal unions and the CEGB. But there was also the expectation that competition would lead to improvements in the efficiency of operations. Further, privatization and restructuring in a system with excess supply involved very little risk.

[7] It should also be noted that these political considerations may have varied, although reform converged around the same set of principles. Thus for instance, while in Norway reforms were aimed at a pragmatic restructuring of the electricity sector and were initiated by a Labour government, privatisation was off the table from the very beginning. In the EU, reforms were a part of the wider integration process, although member-states had the freedom to decide upon their policy paths. And in the UK, there are still debates around whether it was politics or economics that influenced initial reforms (Rutledge, 2010).

[8]For example, falling prices of fuel inputs could have coincided with reform; similarly, improved labour productivity could simply be attributed to cuts in the labour force following privatization (Rutledge, 2010). The existence of excess capacity at the outset in most of these early reformer countries was also indicative of lower risks (Sen, 2014). Further, technological changes within the industry which were to some extent endogenous to the reform process itself, also played an important role.

[9]Newbery (2013); Keay et al. (2013a; 2013b); Rutledge (2010); Bye and Hope (2005); Magnus (1997); Newbery and Pollitt (1997).

[10]This was a watershed year as the Copenhagen climate change summit saw major developing countries like India adopt ‘national missions’ on climate change mitigation, laying the ground for COP21 in December 2015.

the electricity sector presents the biggest opportunity to bring about the single largest emissions reduction in many countries (IEA, 2015).

Consequently, in OECD countries, reforms have been under review to incorporate emissions reduction goals. In developing non-OECD Asia, however, this poses an additional challenge as governments already struggle to successfully square efficiency objectives of electricity reform with access and distributional objectives.

South Asia alone accounts for 25% of global population yet just 5% of global electricity consumption. Just under a third of India's population of 1.2 billion still subsists on non-commercial energy sources. Moreover, electricity demand in non-OECD Asia as a whole is predicted to double over the next two decades: the International Energy Agency (IEA) predicts that it will rise from 6,317 Terawatt hours (TWh) in 2012 to 13,982 TWh by 2035 (IEA, 2014). Total installed capacity (Gigawatts) in non-OECD Asian economies comprises 30% of global installed capacity, and is predicted to grow to 44% by 2040, but will be insufficient to meet rising demand (IEA, 2014). Emissions from non-OECD Asia, however, already comprise around 38% of global emissions, and given rising demand, there will be increasing pressure from tightening post-COP21 global climate architecture for these countries to tackle environmental objectives. While meeting this demand will be a challenge, doing so in a sustainable way will be even more difficult.

In this chapter we review the progress in adoption of the OECD model of electricity reform in non-OECD Asian developing countries, highlighting the fact that most countries are midway towards the implementation of liberalized electricity markets. However, we also argue that pursuing the OECD model to completion can lead to adverse environmental outcomes in these countries. We conclude that a new paradigm of electricity reform is needed in Asia, which balances economic and environmental objectives.

The remaining sections organized as follow. Section 2 reviews the implementation of the OECD reform model, Section 3 analyses the environmental dimension and its

implications for electricity reform in developing Asia, Section 4 discusses the experiences of three Asian countries – India, Nepal and Bhutan, highlighting not just the contradictions between economic and environmental objectives, but their complexities with cross-border electricity trade. Section 5 concludes.

2. The Standard Reform Model in Non-OECD Asia

From the 1990s, there was a gradual and widespread adoption of the standard model of electricity reform (or its variants) across developing non-OECD Asia. The drivers behind this have been categorized into 'pull factors' and 'push factors' (Nepal and Jamasb 2011). The 'pull' factors included a demonstration effect following experiences in the OECD (Zhang et al., 2008). The 'push factors' were twofold; the first related to the adoption of structural adjustment programmes, e.g. in India as a condition of multilateral financial assistance following balance of payments crises.[11]

The second 'push factor' was related to endemic problems within the electricity sectors of developing countries, and a genuine need for reform. The sector in most developing countries was publicly owned, through vertically integrated entities which carried out generation, transmission, and distribution, as well as infrastructure creation. Vertically integrated monopolies, based on the economies of scale and scope[12] argument, were deemed to be the best way of extending electricity to the majority of the populations that lacked access to it. Similarly, public ownership was justified on the basis that the state was the custodian of public interest, the enabler of necessary coordination among different segments (generation, transmission, and distribution), and necessary to the strategic nature of the sector, given its role in development (Gratwick and Eberhard, 2008).

The concentration of all functions in singular state-owned entities, with no effective self-imposed or independent oversight, led to technical and financial problems (Victor

[11]The literature indicates that much of this was tied to the introduction of private investment through IPPs (Williams and Ghanadan, 2006).
[12]That is, limiting the risks associated with large-scale investment. Governments can also use a public or privately owned monopoly to finance public objectives that the company may otherwise not undertake, such as rural electrification.

and Heller 2007). Transmission and distribution losses in developing economies averaged 20% prior to reform, in comparison with a world average of 9% (Gratwick and Eberhard, 2008). The number of employees per million units of electricity sold was 5 for India, compared with 0.1 for Norway[13] (Sen, 2014). There is a large literature attributing the underlying reasons for these inefficiencies to the politicization of the sector and its capture by politicians to seek votes through the promise of low-priced electricity, partly financed through government subsidies, and partly by the state-owned enterprises themselves. Such actions forced state-owned enterprises to maintain the prices below costs of supply, constraining the amount by which prices could be adjusted upwards against increases in the cost of supply. This in turn limited the amount of capital available for reinvestment in infrastructure and access – thus defeating the original purpose of state-controlled electricity provision and engendering a culture of wastefulness and political opportunism (Tongia, 2003; Dubash and Singh, 2005). In India, this circular problem was demonstrated by the fact that, despite successive increases in expenditure allocated to electricity within the Five Year Plans, capacity addition targets were rarely achieved and state-owned utilities continue to accumulate losses.

Therefore, in developed countries, the underlying logic and objectives for reform were higher efficiency, lower prices, consumer choice, and national competitiveness (Williams and Ghanadan, 2006). In developing countries, the objectives were more to do with the declining state of utilities' finances, propagation of private investment to enable infrastructure, technology upgrades, and removal of the electricity supply constraint on growth. (Williams and Ghanadan, 2006). Developing economies also faced a capacity shortage, which meant that the risks in reform were higher at the outset in comparison with developed economies.

At the time of initial reform, the OECD or standard model was presented as a solution for technical and financial inefficiencies and at infusing transparency into the operations of state-owned enterprises in developing economies. Technological advancements had also rendered the economies of scale argument redundant. Thus, the standard reform model effectively represented a 'common path' but to 'different

[13]Norway carried out reforms entirely within the public sector.

goals' for the OECD and non-OECD economies. Further, although there was a general sequence that had been intended to shape the basic reform measures,[14] non-OECD Asian economies ended up adopting variations of it, as reform tended to occur in fits and starts.

Table 2.1: Electricity Reforms in Non-OECD Asia, 2013

	Independent Power Producers	Regulator	Unbund-ling	Corporat-isation	Open/Third Party Access[15]	Distribution Privatisation
Bangladesh	x	x	x	x		
Bhutan	x	x	x	x		
Brunei		x				x
China	x	x	x	x		
India	x	x	x	x	x	x
Indonesia	x		x	x	x	
Laos	x					
Malaysia	x	x	x	x		
Maldives	x	x		x		
Myanmar	x	x				
Nepal	x	x	x	x		
Pakistan	x	x	x	x		
Philippines	x	x	x	x	x	x
Singapore	x	x	x	x	x	x
Sri Lanka	x	x				

[14]A 'scorecard' for electricity reforms, citing the different steps and the sequence, was developed to broadly measure progress (Bacon, 1999).

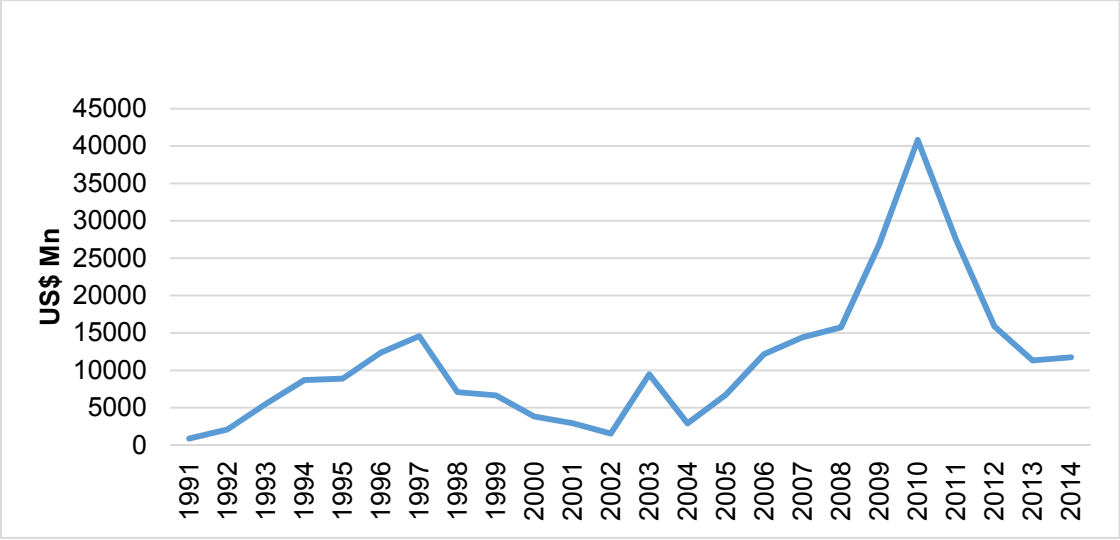
[15]Open access has been implemented to varying degrees; in the majority it has been confined to large consumers.

Thailand	x	x	x	x	x	
Vietnam	x	x	x	x		

Source: Sen et al. (2016)

Table 2.1 depicts the progress of reforms set against the 'standard' reform model used to assess its milestones for 17 prominent non-OECD Asian countries. The entry of Independent Power Producers (IPPs) into generation is the most widely adopted measure (Figure 2.1), but only four countries have progressed to distribution privatisation. Further, open (or third party) access, a fundamental enabler of retail competition has been adopted in just 5 countries, and restricted to large consumers. Experiences have been mixed across countries.

Figure 2.1: IPP Investments in Asia, 1990-2014



Source: World Bank PPI Database[16]

One of the main motivations for the introduction of IPPs, the most popular measure, were introduced, was they there were a quick way to introduce competition without significant restructuring.[17] They transferred investment risks to utilities and in some

[16]Graphed according to the year of financial closure.
[17]IPPs were also a way of adding capacity.

cases ultimately to consumers (through higher tariffs) through the 'take or pay' clauses prevalent in many contracts. While some countries (e.g., Malaysia and Singapore) coped by evolving their sectors to adapt to this risk, many (e.g. India and Pakistan) struggled to harness IPPs to fit with their fiscal and institutional contexts leading to a spate of renegotiations and cancellations (Sen et al., 2016).

However, political factors have markedly impeded IPPs' success. For instance, the Philippines in the 1990s successfully contracted IPPs for 40% of generation capacity, as did Indonesia – however, following the Asian financial crisis a spate of renegotiations uncovered allegations of patronage in the awarding of IPP contracts in both countries (Henisz and Zelner, 2002; Wu and Sulistiyanto, 2013).

Among smaller countries, Laos, Bhutan and Nepal have significant hydropower potential, some of which has been developed through IPPs. However, concerns over property rights and sovereignty have prevented their progress. In China, the lack of grid integration meant that despite the early introduction of IPPs, capacity surpluses could not be spread to deficit regions, making IPP investments susceptible to regional supply and demand fluctuations (Wu, 2005b). The reorientation of multilateral financing towards clean energy has stalled IPPs in newly hydrocarbon-rich countries such as Bangladesh and Myanmar.

Although the majority of non-OECD Asian countries have established some type of electricity regulator, in most cases these are not independent from government. In countries where electricity reform is lagging, the main issue faced by regulators relates to reforming tariffs to reflect costs (e.g., India, Pakistan). Where markets have largely developed, issues include the mitigation of market power, which in many cases is exercised by state owned companies (e.g. Thailand, Philippines). Some countries such as China have aimed to consolidate electricity regulation with other energy-related sectors. In smaller oil import-dependent countries such as Maldives, the regulator plays a critical role in the country's trade balance.[18] Although the majority of countries have implemented unbundling and corporatisation, public sector provision largely dominates and in many cases the finances of distribution companies have not

[18]Maldives aims to achieve 'carbon neutrality' in energy by 2020.

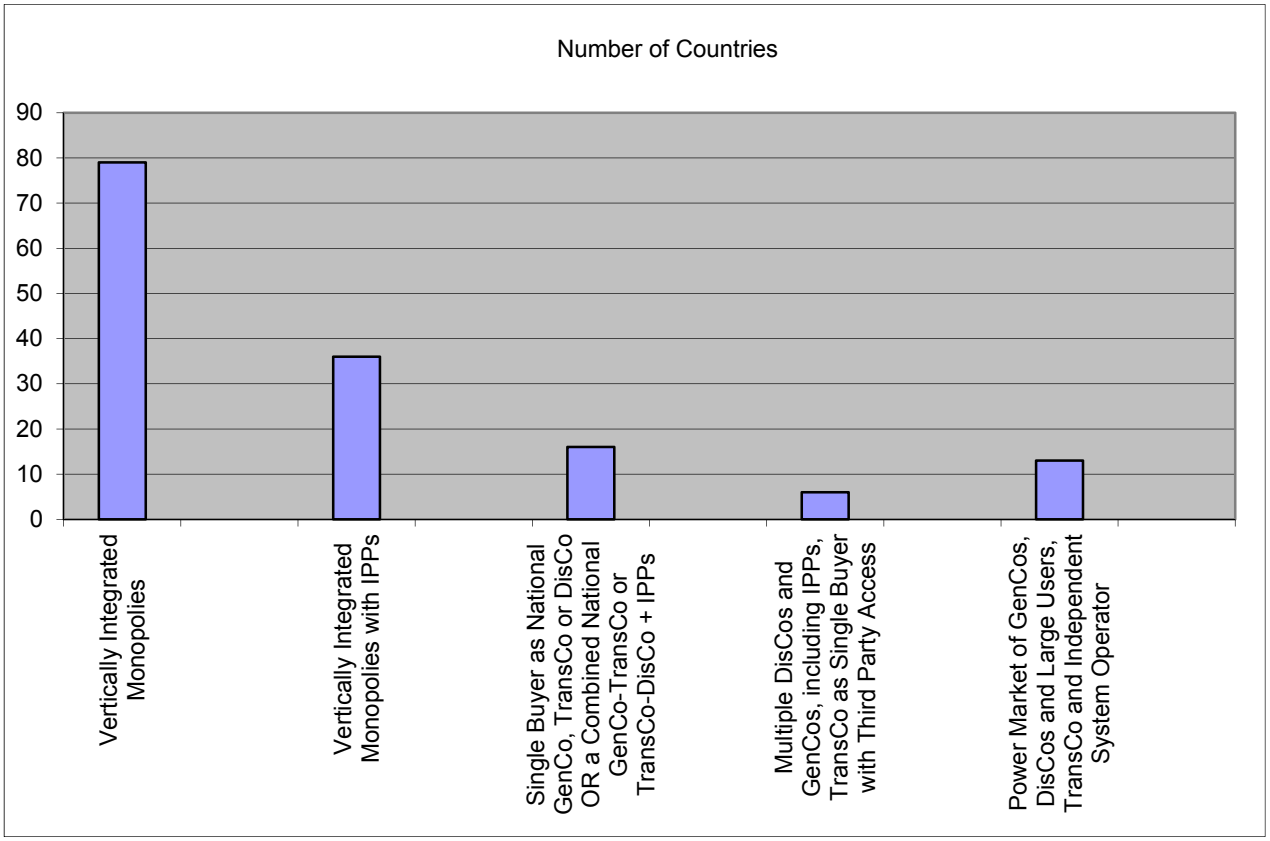
improved. Indeed, Nepal and Jamasb (2012b) argue that in smaller systems (e.g. Nepal), the creation of an independent regulatory authority may be more important than unbundling, particularly for politically unstable countries and especially where hydropower is predominant.

Open access has been implemented in just five countries, with some obstacles. In India, for instance, the main impediment has been the imposition of 'surcharges' by public utility companies on large industrial consumers to compensate for the loss in revenue.[19] In Indonesia, the state company PLN continues to be the sole owner of transmission and distribution assets as it is given priority rights under the law to conduct its business. In Thailand, despite open access public sector companies operate geographically segregated oligopolies and have majority shares in private generation companies, (Wisuttisak, 2012). Four Asian countries: Brunei, India, Philippines and Singapore have implemented distribution privatisation. Singapore is arguably the most advanced, with seven electricity retailers and the Market Support Services Licensee competing for (contestable) retail consumers. Privatisation in the Philippines' electricity distribution sector has on the other hand resembled the switch from a public to a private monopoly. India has had mixed experience with distribution privatisation - Odisha in 1996, carried out without restructuring, and Delhi in 2002, with bids were awarded on the basis of the largest promised reductions in average commercial and technical losses, with the gains shared with consumers. In May 2015 Odisha's state electricity regulator revoked the licenses of the three private distribution utilities, citing 'gross failure in raising their performance and financial health, reducing distribution loss, preventing theft of energy and running the organisation in a financially viable manner' (Mohanty, 2015). Distribution assets were consequently taken over by the state-owned grid management company GRIDCO.

It is therefore evident that developing Asian economies (and developing countries in general – see Table 2.2) have implemented hybrid versions of the standard OECD reform model, as their reform processes have often been influenced by country-specific heterogeneity

[19]Industrial consumers cross subsidise agricultural consumers; hence in the absence of tariff reform, open access has serious financial consequences for public utilities.

Figure 2.2: Structure of the Electricity Sector in 150 Developing Countries



Source: Gratwick and Eberhard (2008); Besant-Jones (2006)

Note: GenCo, TransCo, DistCo refer to generation, transmission and distribution companies.

3. Electricity Reforms and Environmental Objectives

As Table 3.1 below shows, electricity (and heat) production account for the largest proportion of emissions from fuel combustion across most economies, implying that the electricity sector presents a significant opportunity for potential emissions reduction.[20] This is why in OECD countries (particularly the EU) environmental objectives have mainly been pursued through decarbonisation of the electricity sector.

[20]Followed by transport – however, many countries are aiming for the electrification of transport to mitigate emissions.

Table 3.1: CO_2 Emissions by Sector, 2013 (million tonnes of CO_2)

	Electricity & Heat Production	Other Energy Industry Own Use	Manufacturing and Construction	Transport	Residential	Other	Total CO_2 Emissions from Fuel Combustion
OECD	4,866	722	1,378	3,384	932	755	12,038
Asia	6,069	504	3,665	1,428	483	481	12,630
India	4,386	367	2,806	754	330	334	8,977
China	945	43	493	222	87	79	1,869
Africa	435	88	137	289	69	58	1,075
Middle East	639	121	344	386	124	35	1,648

Source: IEA (2015)

Under the OECD model, electricity prices in liberalized wholesale markets are set according to system marginal cost - the short-term marginal cost of the last (and, following the merit order, typically most expensive) plant that is required to be brought onto the system in order to meet demand.[21] Generation companies are incentivized to compete on costs, as those with lower short-term marginal costs than the system marginal cost will gain from this. These markets are also referred to as 'energy only markets' in that the incentives to encourage more investment in generation are considered as being built into the price signals, rather than through externally imposed generation adequacy standards[22]. The market effectively determines how much generation capacity is required (UKERC, 2010). Energy-only markets are largely

[21]This section draws from Keay et al. (2013a; 2013b); Buchan and Keay (2014); Keay (2013a; 2013b; 2009), Robinson (2013), Rhys (2013) and Sen (2014).
[22]Such as by a government or regulator.

designed to match the characteristics of conventional (fossil) fuel generation and investment (Keay et al., 2013a; 2013b).

Renewable energy has high capital costs but a zero marginal cost of operation. Further, renewable energy is intermittent[23] and while during periods of abundant availability supply could be sufficient to match demand, the intermittency requires that 'backup' generation be available to ensure continuity of supply. It is important that this backup is flexible and able to adjust quickly to demand – implying the use of fossil fuels, hydro or nuclear (Sen, 2014).

Two problems emerge here: first, in order to encourage the capital intensive investments in renewables governments have to offer support schemes such as Feed-in Tariffs (FiTs) or other subsidies which undermine the role of the liberalized market in setting prices and in motivating investment. Second, the unpredictability of renewables (e.g. wind) implies that market prices will either be set equal to zero marginal costs (e.g. during periods of abundant wind) or set at very high levels at times when renewables are low or unavailable (in order to allow backup generators to recover their costs and justify capital investments in backup generation). This could imply shorter periods of zero or low prices and longer periods of very high prices (Keay et al., 2013a; 2013b); these high prices would be difficult to justify to a public which already questions high energy prices, as market liberalization was largely propagated on the basis of 'competitive' prices (Sen, 2014).

Further, if renewables are integrated into wholesale markets in their current form, they may not even recover their fixed costs (without extra-market payments) because when they run, prices would be low or zero (Robinson, 2013). It has also been argued that support schemes such as FiTs discourage innovation through 'cherry picking technologies' thereby impeding reductions in the capital costs of renewable energy (Keay et al., 2013a; Keay, 2013b). Arguably, even if the technical costs of renewable energy were to decline over time, system or resource costs could continue rising, as the resource may tend to get costlier the more it is exploited (Keay, 2013a).[24]

[23] E.g. wind, and solar in the absence of large-scale commercial storage technologies.
[24] In other words, the easiest and best sites for the development of renewable energy are likely to be used up early on (Keay, 2013a).

These problems reflect some of the inherent contradictions between the OECD model and newer environmental objectives of reforms in which the sector needs to rely increasingly on renewable energy sources. The solutions that have been advocated to this problem in OECD countries can be categorized into two: the greater use of markets to ensure investments in both renewables and backup generation (that is, the setting up of separate capacity and balancing markets in addition to energy-only markets), or conversely, the establishment of a single-buyer agency to coordinate the integration of renewables into the electricity sector (Keay et al., 2013a; 2013b; Newbery, 2013).

The shift to a sustainable, low carbon electricity system does not preclude the original hurdle of cost-reflective pricing. Asian countries continue to grapple with important distributional issues, and in the past the direct use of the pricing system to address these issues has led to regressive outcomes, which have ended up benefitting the rich. Systems of direct cash transfers to eligible consumers have been adopted in some countries (e.g. India, Indonesia) as a method of removing pricing distortions and targeting poorer consumers for subsidies.

3.1 Economic vs. Environmental Objectives in Asian Developing Countries

One way of viewing the contradictions between economic and environmental objectives in the OECD reform model is that markets and institutions created through reforms may gradually evolve to resolve these conflicts. However, three factors suggest that a paradigm shift in the reforms process is critical in Asian developing economies. The first and most obvious one is rising electricity demand. The second is that for developing countries, the amount of effort required to bring about a policy outcome can be disproportionate to the value of that outcome (Sen and Jamasb, 2013)[25], necessitating proactive policy choices in the short term.

[25]Referring, for instance, to the difficulties governments have had with implementing cost-reflective pricing, despite the last two decades of electricity reform.

The third is that these countries stand to lose the most from climate change in terms of its human costs (IPCC, 2007), and it can be assumed that their citizens will hold governments accountable for inaction – in other words, environmental policy is becoming as much a political issue as cost-reflective pricing. This has indeed been seen recently in countries such as China and India. For instance, in late 2015 citizens in Delhi launched litigation against municipal authorities on grounds of their inaction to combat rising urban air pollution, proven to be detrimental to human health.[26]

As Table 1.1 showed, any serious effort at decarbonisation would need to have the electricity sector at its core, as electricity comprises the largest source of emissions across the board, and provides the most direct way to reduce emissions (Keay, 2009). In this regard, non-OECD Asian countries face a series of challenges in balancing economic and environmental objectives in the process of electricity sector reforms. We summarise the main ones below.

3.1.1 Investment in generation

While energy-only markets focus on short-term marginal costs, they do not separately take into account long-run marginal costs, which are directly related to investments in generation. The problem of adequate investment in generation under the OECD reform model stretches across developed and developing countries; however, the nature of the investment problem is different for both. In developed countries the concern is whether markets will deliver investments in renewables and backup generation, or whether a single buyer agency should take on the task. In Asian economies, the single buyer (central planning) model has arguably failed to deliver adequate investment in both conventional and renewable generation.

The investment problem faced by Asian countries is complex: it requires a solution that (a) ensures universal access to electricity, (b) is based on cost-reflective pricing, (c) integrates renewables onto the system, and (d) is free from political appropriation. The design of investment mechanisms for developing economies necessitates a

[26] See 'Notice to Centre, Delhi government, after plea on pollution by Toddlers', Indian Express, 8 October 2015. http://www.ndtv.com/delhi-news/notice-to-centre-delhi-government-after-plea-on-pollution-by-toddlers-1229910

closer look at the hybrid market structures that have emerged in these economies – in terms of identifying all these structures and working out how they could function in conjunction with each other towards a defined set of goals. Essentially, this strategy could comprise a looser, less sophisticated approximation of the 'multiple markets' solution being considered in the UK.

3.1.2 Access and the proliferation of coal

Most Asian developing countries continue to struggle with extending access to electricity. If developing countries were to fully implement the OECD model (full electricity market liberalization assuming that the problem of cost-reflective pricing and finances of utilities were addressed along the way), then the system could arguably be successful in balancing electricity generated from renewables with electricity from conventional (fossil) fuels. The irony here is that backup generation is likely to be coal – which is cheap and plentiful but environmentally far more damaging than say gas, which is its closest substitute – constituting a significant policy contradiction.

Despite this limitation of markets, it is by no means certain that a central planning agency would advocate the exclusion of coal from the energy mix, particularly as energy has been viewed as a balance of payments problem in net-importing Asian countries (Sen, 2014). Countries therefore need to implement some form of a (binding) carbon price to square the balance between economic and environment reform objectives.

An added dimension is the role of multilateral financial institutions, which provided the original catalyst for electricity reforms. Although many have discontinued lending to coal projects, International Financial Institutions (IFIs) accounted for roughly US$51 billion in the financing of coal-related projects from 2007–13.[27] Some multilateral finance institutions have announced that they will cease funding inefficient coal projects. By some accounts, bilateral finance to coal-fired power from Exim banks and export credit agencies, has formed the larger proportion of IFI financing over the last five years.

[27] See www.huffingtonpost.com/jake-schmidt/too-much-public-funding-i_b_4314333.html.

3.1.3 Cross-border electricity trade

One approach being pursued in OECD countries with a view to the promotion of clean energy, the reduction of costs in its provision, and the availability of electricity to countries that face a deficit, is regional electricity market integration. 'Large regional markets', achieved through cross-border integration, have been proposed as a way of ensuring greater flexibility in the response of generation to demand, as a larger pool of plants is available to call upon for dispatch (Riesz et al., 2013).

For instance, the EU's climate and energy package sets binding legislation for its '20-20-20' targets – namely, a 20% reduction in EU greenhouse gas emissions from 1990 levels, raising the share of EU energy consumption from renewables by 20%, and a 20% improvement in the EU's energy efficiency –to be achieved by 2020, with a longer term goal of an 80–95% reduction in emissions by 2050. This is to be achieved through a set of policy tools based on greater market integration[28] combined with nationally-driven targets on emissions reduction. Several regional electricity market integration initiatives exist in Asia, supported by multilateral finance (such as the ADB) – for instance, electricity trading in the Greater Mekong sub-region (GMS) – comprising Cambodia, Laos, Myanmar, Thailand, and the Yunnan Province and Guangxi Zhuang Autonomous Region of China – primarily takes place through bilateral exports. In South Asia, interconnections exist between India, Bangladesh and Bhutan.

The OECD reform model has however led to conflicts between national and regional targets in the EU. For EU countries such as France, where 75% of electricity is generated from nuclear energy and is low-priced by European standards, greater market integration is likely to led to higher prices (at least initially), which is unlikely to be accepted by French consumers who initially had to pay higher tariffs to finance the early capital investments in nuclear energy (Percebois, 2013). Also, there is some ambiguity over EU regulations against national governments providing 'state support'

[28]See http://ec.europa.eu/clima/policies/package/index_en.htm for details. The EU Emissions Trading System has been widely criticized for its ineffectiveness.

to emissions reduction schemes that are unsanctioned at EU level, as this could be seen as undermining the principle of competitive markets.

4. Balancing Economic and Environmental Objectives – The Case of Three South Asian Countries

The current debates over the suitability of the OECD model in delivering on both economic and environmental objectives presents an opportunity for Asian developing countries, most of which have progressed little, or midway, towards implementing the model, to identify solutions which can address both objectives *without* mimicking the experience of OECD countries. Essentially, from the above discussion it can be argued that this would entail delivering electricity through a system which encompasses 1) low emissions 2) a suitably flexible baseload to intermittent renewables 3) a competitive price, particularly with regard to low income consumers, and 4) adequate market incentives (or pricing signals) for investors.

A prominent means of balancing these objectives has been attempted through inter-regional electricity market integration[29], such as in the cases of the EU (described above) and in other parts of the world.[30] In this section, we explore this further through a comparative case study using three countries based on 1) geography; 2) shared experiences of electricity reform; and 3) ongoing efforts towards greater regional market integration. The three South Asian countries analysed here are: India (which accounts for the largest regional share of emissions and abundant low cost coal reserves), Bhutan, and Nepal (which both account for the highest reserves/potential of hydropower in the region, mostly underdeveloped). In such a market, given that hydro reserves are subject to sovereign property rights, the role of private investment and markets (relatively advanced in India) would largely be concentrated on *infrastructure* and other renewables capacity (e.g. solar).

[29] See Singh et al. (2015) for a discussion of how political economy factors can sometimes constrain regional electricity market integration, using a case study of South Asia.
[30] Latin America, and the Greater Mekong region in East Asia.

In this section, we first review country experience on electricity reforms against the context of economic and environmental objectives for India, Bhutan and Nepal. We then analyse the argument for greater market integration as a potential solution to achieving the 'balance', and barriers to the same.

Table 3.2 Key electricity indicators: India, Bhutan, Nepal

	Installed capacity (MW)	Peak demand (MW)	Electr-icity deficit (% peak demand)	IPPs as capacity (%)	Access rate (%)	Technical losses (% consumption	Per capita consumption (kWh)	Hydro potential (GW)	Coal reserves (Bt)
India	24,3021 8	129,81 5		34.0	75	23.65	917	148	126
Bhutan	1,615	336			95.5	9.3	2,600	33	-
Nepal	787	1,200	40	33.3	76	25.03	106	83	-

Source: Yangki and Tashi (2016); World Development Indicators; UNOSD (2014); Authors

4.1. *India*

Power sector reforms in India have been undertaken in three phases (Victor and Heller, 2007). The first phase, in 1991, focused on the introduction of IPPs into generation, with little success. Enron's attempt to set up an IPP widely cited as the failure of India's 1991 effort to open up the power generation sector (Mukherjee, 2014).[31] The second phase, in the mid-1990s, constituted state-level efforts at restructuring State Electricity Boards into unbundled companies and setting up independent electricity regulatory commissions.[32] The third phase was marked by the legislation of the Electricity Act in 2003, which consolidated and replaced all previous federal laws governing the electricity sector, and was a fairly momentous step forward in India's hitherto unsteady reform progress. The provisions of the Act aimed to transform the electricity market from a non-competitive, Single Buyer Model to a

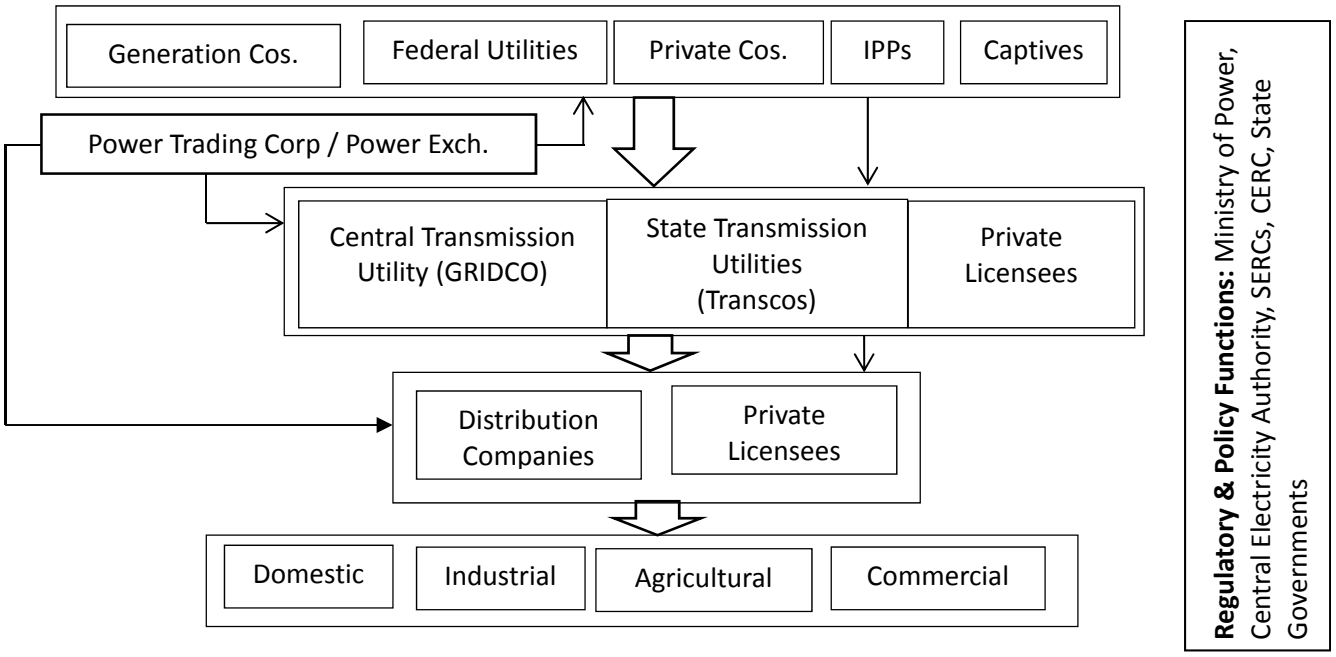
[31]Enron's early attempt to set up an IPP in India ran into significant problems, with allegations over excessively high tariffs in the Power Purchase Agreement with the State Electricity Board (which the Board allegedly could not afford to pay) leading to the state government of Maharashtra reneging on its agreement with Enron. After several years mired in expensive litigation, Enron exited the project, shortly before its own financial collapse. The project has since been taken over by a public consortium, which is still struggling to revive it to its originally envisaged full capacity. See Mukherjee (2014) for a discussion of private participation in generation in India and the Enron experience and Sant and Dixit (1995) for arguments in favour of the cancellation of the project at the time.

[32]Orissa in 1996, Haryana in 1997 and Andhra Pradesh in 1998.

Multiple Buyer Model with several competing participants in the generation, transmission and distribution segments. Sen and Jamasb (2013) provide a comprehensive analysis of power sector reforms in India.

Consequently, India has a hybrid version of the OECD/standard model; state-owned utilities exist alongside private companies in generation and distribution, and power is mostly traded through Power Purchase Agreements while a relatively small but growing proportion of electricity is traded on short-term markets through power exchanges and bilateral contracts.[33] In Figure 3.1, the top row represents generation – comprising a mix of federal and state government utilities, private and privatized companies, IPPs, and captive generators. Two power exchanges and the state-owned Power Trading Corporation of India (second row) facilitate a small percentage of market-based trading, whereas the majority of trade is carried out through longer-term Power Purchase Agreements. The third and fourth rows depict transmission and distribution companies (retail supply and distribution are integrated) which include government (federal and state)-owned companies as well as private licensees, and the last row shows categories of consumers.

Figure 3.1: Power Sector Restructuring in India



[33]Approximated at 11% of the total electricity market. The short-term power market in India covers contracts of less than a year's duration transacted through trading licensees, power exchanges, direct trading between distribution companies, and through 'unscheduled interchanges'. (CERC, 2013).

Source: Singh (2010)

There are three distinctive characteristics of India's electricity reform experience. First, despite the early failures with IPPs, the latter have provided a functional alternative to the lack of public sector capacity additions. The government's planned programme of adding supercritical coal-fired generation plant capacity through 'Ultra Mega Power Plant' projects[34] have faced similar issues with tariff levels and the economic viability of distribution utilities to purchase power from IPPs. These issues have been partially resolved through the increase of low-cost domestic coal production and the auctioning of domestic coal supply linkages to IPPs.[35] Notably, briefly India achieved a 'surplus' of power for the first time in decades in 2016-17.

A second characteristic is that India is beginning to demonstrate problems similar to those seen currently in the OECD, where a system based on marginal cost pricing cannot cope with the intermittency of renewables, whilst linking in with long-term incentives for investment in backup generation. Attempts at incorporating renewables have run into problems. For instance, a 'renewables purchase obligation' (RPO) requires distribution utilities to purchase a certain proportion (set by state regulators) of electricity from renewables, or alternatively an equivalent amount in 'renewable electricity certificates' (each equating to 1 MWh) on India's two main power exchanges. However, the exchanges have reported a growing inventory of untraded certificates since the programme's inception. For instance, the Indian Electricity Exchange, which accounted for over 90% of the domestic electricity trading market in 2015, reported that of 9.6 million certificates available in fiscal 2014-15, only 3.1 million had been traded.

A third characteristic is the continued failure of state-owned distribution utilities to enforce cost-reflective pricing, implying that they are often unable to fulfil their RPOs. A debt restructuring programme announced in November 2015, asked state

[34] The details of this programme can be found at http://powermin.nic.in/upload/pdf/ultra_mega_project.pdf

[35] The Indian government in 2014/15 carried out a series of 'reverse auctions' for coal to IPPs. This has been criticised as an unsustainable solution from the point of view of climate/environmental goals, as it encourages the use of coal.

governments to appropriate 75% of distribution utilities' debts over a period of 2 years. Following this the debts were to be included as part of state fiscal deficits, thereby necessitating that states take parallel measures to increase power sector tariffs and eliminate subsidies. The incentive to states which implement this reform was the according of priority in other federal funding. However, two previous attempts at debt restructuring have failed, as it is incumbent upon state governments (often reluctant to increase tariffs for their constituents) to implement reform.

Despite the penetration of competitive markets into India's electricity sector, problems continue to exist with regional imbalances and constraints to the evacuation of power, the most prominent illustration of which was the simultaneous failure of three of India's five regional transmission grids in July 2012. In February 2016, the percentage composition of India's 289 GW of installed capacity was: coal (61), oil (0.34), gas (8), nuclear (2), hydro (15) and renewables (13). Within renewables, solar and wind were 13 and 65 per cent, respectively. According to the IEA, CO_2 emissions from electricity comprise the single largest proportion (44 per cent) of total CO_2 emissions from fuel combustion in India. Given that roughly a third of its population lack access to modern commercial energy, India's government in 2014 set a target of providing '24x7 electricity to all' by 2019. Despite the environmental implications, India's government plans to triple coal production to 1.5 bn tonnes by 2019 to meet this target. While India plans to add 100 GW of solar, 60 GW of wind and 15 GW of other renewables to installed capacity by 2022, these require an exponential growth in the renewable energy market which is unlikely to be achieved.[36] Further, it faces issues over land acquisition and resettlement pertaining to new (as well as existing) hydro power projects. The viability of this target is therefore contingent not just upon the continued expansion of installed capacity in a sustainable manner, but also on further technical and financial reforms to the electricity sector. Given its dual emissions and development implications, the power sector therefore represents the biggest hope for a successful confluence of India's electricity and climate policy, but at the same time, its biggest hurdle.

[36]For instance, in order to meet the solar target (solar comprised 5GW of installed capacity in 2016) the solar energy market has to add 12 GW/year, from current levels of 1GW/year. (See Sen, 2016).

One way of achieving this is through regional electricity market integration with neighbouring South Asian countries which have considerable hydro and gas resources. India already has an interconnection with Bangladesh which supports 500 MW and is being upgraded to 1000MW. There have been discussions since 1970 on a sub-marine India-Sri Lanka HVDC link, and India has interconnection and trading agreements in place with Nepal and Bhutan (discussed below). More importantly, with its status as South Asia's largest (and growing) electricity market and quasi-competitive structure (particularly in generation), India will play a pivotal roles in facilitating South Asia's regional electricity market integration.

4.2 *Bhutan*

Bhutan joined the global reform bandwagon in the mid-1990s. Key drivers of reforms in the Bhutanese power sector were: i) the institutional weakness of the sector, (ii) inability to assume the role of key growth driver in promoting the country's economic development through power exports, iii) providing access to electricity for rural consumers and iv) poor cost recovery and dependence on donor financing for new investments (ADB, 2010). Table 3.2 summarizes the major reform timelines and the current status of the Bhutanese power sector. The wholesale market is based on a single buyer model (SBM) consisting of multiple buyers and single seller. The electricity supply industry is vertically integrated with only functional separation of generation, transmission and distribution. Private participation in the generation segment was initiated in 2008 while independent regulation was instituted in 2010.

Table 3.3 Reform Timeline in Bhutan

2001	Electricity Act passed
2002	Functional unbundling of the Power Sector Bhutan Power Corporation made responsible for Transmission and Distribution
2008	Druk Green Power Corporation Limited (DGPC) was established in January, 2008 and made responsible for developing, maintaining and operating hydropower plants owned by the Royal Government of Bhutan (RGoB)
2010	Bhutan Electricity Authority (BEA) made responsible for regulation and became fully autonomous in January, 2010

Source: Yangki and Tashi (2016)

Regulatory and institutional reforms in the energy sector have successfully contributed to the development of hydropower in Bhutan. The economy that was once solely reliant on foreign aid now is self-reliant due to hydropower revenue which has been ploughed back into social and industrial sectors. Domestic tariff has been kept low to increase energy affordability and stimulate economic growth. Rural electrification is high priority in Bhutan implying universal urban electrification and 99% rural electrification. Notably, a continuous supply of electricity is available to industrial consumers.

India and Bhutan signed a bilateral agreement in 1996 under the Indo-Bhutan Power exchange. The agreement provided that all surplus power would be sold to the Government of India (GOI) which in turn GOI is committed to purchase all the surplus power (Saran, 2014). An umbrella agreement was signed in 2006 under which India provides project investigation, design and engineering services, constructional supervision and highly concessional finance for upcoming hydro projects which allows India to supply power to Bhutan under a swap arrangement. Electricity sales (domestic and export) amounts to over 45% percent of the total internal government revenues, and 20% of GDP. Around 75% of electricity was exported to Bhutan's largest trading partner India, in 2014 (Yangki and Tashi, 2016).

Hydroelectric energy is considered to be a clean form of renewable energy in Bhutan with a potential of 83 GW. Hydroelectricity exports have allowed Bhutan to offset 4.4 million tonnes of CO_2 annually with the potential to offset up to 22.4 million tonnes of CO_2 per year by 2025 (Arora and Dema, 2016). Most projects are run of the river and therefore environmentally benign, due to the rivers flowing through deep valleys while rich forests cover 70% of the land. Bhutan's constitution also mandates that its territory be covered by at least 60% percent by forests (Arora and Dema, 2016). This target may need revisiting considering Bhutan's growing population and concurrent energy and development requirements.

4.3 *Nepal*

Power sector reform in Nepal has been unsuccessfully pursued since the early 1990s, and marked by political instability resulting in discontinued policies and an environment which has disincentivised investment. The original drivers of reforms included the inability of the sector to extend electricity access to all consumers, inability to attract investments in electricity generation, high transmission and distribution losses and electricity theft. Nepal and Jamasb (2012) and Singh et al. (2015) summarize the historical contexts, drivers and various attempts towards reforming the Nepalese power sector. After more than two decades of the initial reform attempt, the state-owned Nepal Electricity Authority (NEA) still remains a vertically integrated entity with minimal functional separation among generation, transmission and distribution operating under a Single Buyer model. A legally independent regulator was introduced 1993, but subsequently revoked, and then reinstated in 2011. IPPs in electricity generation were originally introduced in 1992.

Table 3.4 Reform Timeline in Nepal

1984	Nepal Electricity Authority Act, 1984 enacted to set up Nepal Electricity Authority (NEA)
1992	Hydropower Development Policy 2049 (1992) issued.
1992	The NEA Act amended to “enable the NEA to function autonomously”. NEA transformed from being as a sole player to a licensee to buy electricity generated by private IPPs.
1993	Electricity Regulations, 1993, introduced to operationalize the Electricity Act, 1992 to enable entry of IPPs.
2001	Hydro-Power Development Policy, (2058) 2001 issued to develop country's hydro resources including those for export purposes.
2006	Rural Energy Policy 2006 issued to address, among others, the energy needs of the rural population, creation of a rural energy subsidy scheme.
2013	Subsidy Policy for Renewable Energy (2069) issued to increase access to renewable energy to low-income households through subsidy and access to credit, to support rural electrification and to attract private investors.

Source: Nepal and Jamasb (2012)

The performance of the Nepalese power sector after more than two decades of reforms is not satisfactory when assessed against the anticipated outcomes. Transmission and distribution electricity losses are relatively high at 25%. Around 50% of the population is connected to the grid, while around 25% have off-grid access. However, the supply and demand gap was about 410 MW resulting in load shedding up to 14 hours a day in 2013 (World Bank, 2015). As such, the lack of access to reliable grid electricity is one of the key obstacles in overcoming poverty reduction and a major constraint to an export-led economic growth. Electricity tariffs continue to remain below cost-recovery levels. However, notable progress has been made with IPPs, which account for 33% of total installed capacity.

A Bilateral Power Trading Agreement between Nepal and India commenced in 1966 with an initial exchange of 5 MW in 1971. Three river treaties (Koshi, Gandak and Mahakali) were also signed between these countries to support power generation and trade (Saran, 2014). Power Trading Corporation (PTC) representing the GOI has signed a power purchase agreement with Nepal for supply of 150 MW for 25 years through the upgrade of existing 132 KV transmission links. In 2014, a Power Trade Agreement (PTA) was signed between Nepal and India although its implementation continues to be pending (Bhat, 2016). Hence, the PTA has not yet delivered the anticipated benefits arising from market accessibility due to slow progress in implementation although the hopes are high.

Like Bhutan, Nepal also relies on hydropower which is considered to be clean and renewable, originating mostly from run of river projects. Nepal has the potential to generate 83GW (with around 40GW commercially feasible) of hydroelectricity. Hence, the environmental benefits in terms of carbon offsets by generating hydroelectricity and trading with India (and even South Asia) are large (Timilsina et al., 2015). Nonetheless, unlike Bhutan, Nepal does not have any mandate to ensure any minimum forest coverage of its territory.

It is evident that regional electricity market integration through hydropower in the three South Asian countries presents one solution that meets the four objectives laid out at the beginning of Section 3. The electricity sector/market structures of the three

countries arguably facilitate this – for instance referring back to Table 2.2, Bhutan and Nepal represent a sector structure similar to Models B and C, whereas India represents a market similar to D and E. Market integration particularly presents significant gains for emissions reduction. It is estimated that every GWh of coal fired generation In India releases close to 1,000 tonnes of CO_2 (Wijayatunga et al., 2015). Indeed, some studies attempting to quantify the benefits of such as solution arrive at positive results. Toman and Timilsina (2016) for instance set out the gains in terms of a more balanced distribution of regional installed capacity, composition of installed capacity – reductions in thermal (coal) and increases in renewable (primarily hydro) capacity, increases in transmission capacity and resultant reductions in emissions, relative to a baseline scenario.

Table 3.5: Gains from Increased South Asia Electricity Integration

Changes in countries' total installed generation by 2040 (GW)	Afghanistan (+4), Bangladesh (-11), Bhutan (+9), India (-35), Nepal (+52), Pakistan (-13), Sri Lanka (-1)
Changes in regional installed generation capacities by 2040 by technologies (GW)	Hydro (+72), Coal (-54), gas (-6), Wind (-7)
Changes in cross-border & inter-grid transmission capacities (GW)	Net increase in cross-border transmission capacity (+95); Inter-grid capacity in India (-37)
Reduction of regional power sector CO_2 emissions	8%

Source: Toman and Timilsina (2016)

Wijayatunga et al. (2015) examines the economic benefits of six interconnections within South Asia (India Nepal 400 kV; India-Sri Lanka Submarine Link; Bangladesh-India HVDC Link; India-Pakistan 220/400 kV; CASA 1000 Link) by comparing their investment costs and their gains – importantly, the latter includes the benefits of unserved energy reductions(i.e. alleviating power shortages and facilitating greater access). It finds that the six interconnections could lead to a total benefit of over $4 Bn against a cost of one-tenth of that amount. When unserved energy reductions are excluded, the benefits are largely confined to fuel (or dispatch) related cost savings;

the break-even utilisation level for a high-cost link to recover a decent return on investment would be very high (Wijayatunga et al., 2015). Unserved energy reductions are therefore an important distinction in developing countries as opposed to developed countries, and imply that regional electricity market integration in developing Asian is not subject to the same caveats as in OECD markets.

5. Conclusions

This chapter has described and analysed the seemingly contradictory objectives of electricity sector reform: between economic efficiency and environmental sustainability via decarbonisation, with specific regard to developing Asia. While electricity sector reforms have aimed at economic efficiency, there has also been a recent move towards incorporating decarbonisation as an objective of reforms, as an effective way of reducing emissions.

Our review of electricity sector reform with reference to economic efficiency concluded that despite the initial promise of electricity reforms, the 'one-size-fits-all' approach has not worked in Asian developing economies. One reason for this is that, while standard reform models implicitly assume stable institutional, regulators, and political frameworks, many developing countries lack strong institutions required to underpin successful reform (Gratwick and Eberhard, 2008). In addition, factors such as initial resource endowments and the size of electricity systems have also been identified as having the potential to affect outcomes (Jamasb et al. 2015; Nepal and Jamasb, 2011). Other differences in starting conditions are also important (e.g. reforming in a situation of excess capacity where average costs are above marginal costs, as opposed to deficits, where they are below marginal costs).

Two factors have stood out on why developing Asian economies have been unsuccessful in implementing reforms to achieve economic objectives. The first is the continual inability of governments to implement cost-reflective pricing. This has given rise to a circular but crucial problem. The absence of cost-reflective pricing to begin with implied that reform was likely to lead to rising prices; thus public opposition to

these price increases typically created an *ex ante* impediment (Sen and Jamasb, 2013; Littlechild, 2000; Newbery, 2000).

A second factor is a shift, sometime in the 2000s, in the focus of reforms from operating efficiency of utilities, to capacity addition, given growing concerns over 'energy security' and shortages. For example in India, captive generation was encouraged as a way of circumventing the lack of grid capacity addition;[37] it has been argued that this 'dichotomy' in electricity sector structure –the state sector coexisting alongside the private sector – had an underlying political basis (Joseph, 2010). It allowed a separation of the problem of supply and shortages from the problem of deteriorating finances in state-owned utilities, thus reinforcing the 'electricity–politics nexus' and circumventing the issue of cost-reflective pricing (Joseph, 2010).[38]

As a result, despite over two decades of reform involving the standard model and its variations, few developing countries, let alone developing Asian countries, have successfully progressed to the extent of full liberalization. These intrinsic obstacles have in the past been regarded as an evolving part of the reform process, overcome through the gradual strengthening of institutions and competition. However, a recently added dimension to the discourse relates to suitability of the OECD model to achieve not just economically efficient but also environmentally sustainable electricity systems, with renewables playing a greater role.

Using three South Asian country case studies, we have argued that the two goals can be potentially balanced by utilising the synergies brought about via greater regional electricity market integration. There are however hurdles to this, such as infrastructure and efforts required to translate bilateral trading agreements into competitive market arrangements. Arguably, one of the determinants of whether market integration will be realised is the cost of off-grid electrification solutions versus the cost of enabling infrastructure and market arrangements required towards greater regional market

[37]In India, the Value of Lost Load (VOLL) was estimated at Rs. 34–122 per KWh, compared with the weighted average of short-term prices on power exchanges at Rs. 4.96 (CERC, 2013). Captive capacity is believed to account for a third of India's total installed capacity.
[38]Industries can generate independently, whereas state utilities which serve residential and agricultural consumers struggle with cost-reflective pricing.

integration. This arguably presents a whole new set of challenges for Asian countries, and also presents an avenue for further research.

References

ADB (2010). Sector Assessment (Summary): Energy, Country Partnership Stratgey: Bhutan, 2014-2018, Asian Development Bank, Manila, Phillipines.

Arora, V. and Dema, C. (2016). Bhutan Should come Clean on Hydropower Megaplan, The Diplomat, Available at: http://thediplomat.com/2016/02/bhutan-should-come-clean-on-hydropower-megaplan/

Bacon, R. (1999). 'A Scorecard for Energy Reform in Developing Countries', Viewpoint, note no.175, World Bank, Washington, DC.

Besant-Jones, J.E. (2006). 'Reforming Power Markets in Developing Countries: What Have We Learned?' Paper no. 19, Energy and Mining Sector Board Discussion paper, The World Bank Group.

Bhat, S. (2016). Post-PTA Indo-Nepal Power Trade, SAARC Dissemination Workshop on Study for Development of Potential Regional Hydro Plant in South Asia, Kathmandu, 09 - 10 May, 2016.

Buchan, D. (2013). 'Limiting state intervention in Europe's electricity markets', Oxford Energy Comment, Oxford Institute for Energy Studies, November.

Buchan, D. and Keay, M. (2014). 'The EU's new energy and climate goals for 2030: under-ambitious and over-bearing?' Oxford Energy Comment, Oxford Institute for Energy Studies, January.

Bye, T. and Hope. E. (2005). 'Deregulation of electricity markets – The Norwegian Experience', Discussion Paper No 433, Research Department, Statistics Norway.

CERC (2013). *Report on Short Term Power Market in India, 2012–13*, Economics Division, Central.

Dubash, N.K. and Singh, D. (2005). 'Of Rocks and Hard Places: A Critical Overview of Recent Global Experience with Electricity Restructuring', *Economic and Political Weekly.* 10–16 December.

Gratwick, K.N. and Eberhard, A. (2008). 'Demise of the standard model for power sector reform and the emergence of hybrid power markets', *Energy Policy*, 36 (10), 3948–60.

Helm, D. (2010). 'Credibility, Commitment, and Regulation: Ex Ante Price Caps and Ex Post Interventions', in Hogan, W. and Sturzenegger, F. (eds) *The Natural Resources Trap Private Investment without Public Commitment*, MIT press.

IEA (2015). *CO_2 Emissions from Fuel Combustion*, International Energy Agency, Paris.

IEA (2014). *World Energy Outlook*, International Energy Agency, Paris.

IPCC (2007). *Climate Change 2007*, Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson (eds) Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Jamasb, T., Nepal, R., and Timilsina, G.R. (2015). A Quarter Century Effort Yet to Come of Age: A Survey of Power Sector Reform in Developing Countries, Policy Research Working paper 7330, June, Development Research Group, The World Bank Group, Washington, D.C.

Jamasb, T.; Mota, R.; Newbery, D.; Pollitt, M. (2004). 'Electricity Sector Reform in Developing Countries: A Survey of Empirical Evidence on Determinants and Performance', Cambridge Working Papers in Economics 0439, Faculty of Economics, University of Cambridge.

Joseph, K.L. (2010). 'The politics of power: Electricity reform in India', *Energy Policy*, 38(1), 503–11.

Joskow, P. (2008) 'Lessons Learned from Electricity Market Liberalization', *The Energy Journal*, Volume 29, Special Issue No. 2, 9-42.

Keay, M. (2009). 'Electricity Market Liberalisation in the UK: the End is Nigh', OIES presentation, to the Electricity Policy Research Group in Cambridge on 26 January, published 1 February.

Keay, M. (2010). 'Can the Market Deliver Security and Environmental Protection in Electricity Generation?',in Rutledge, I.; Wright, P. (eds.), *UK Energy Policy and the End of Market Fundamentalism*, Oxford: OIES/OUP.

Keay, M. (2013a). 'Renewable energy targets: the importance of system and resource costs', Oxford Energy Comment, Oxford Institute for Energy Studies, February.

Keay, M. (2013b). 'UK Electricity Market Reform and the EU', Oxford Energy Comment, Oxford Institute for Energy Studies, April.

Keay, M., Rhys, J., and Robinson, D. (2013a). 'Electricity Market Reform in Britain: Central Planning Versus Free Markets', in Sioshansi, F.P (ed) *Evolution of Global Electricity Markets: New paradigms, new challenges, new approaches*, Academic Press, Elsevier.

Keay, M., Rhys, J., and Robinson, D. (2013b). 'Decarbonization of the electricity industry – is there still a place for markets?', OIES Working Paper EL9, Oxford Institute for Energy Studies, November.

Littlechild, S. (2000). 'Privatization, Competition and Regulation in the British Electricity Industry, with Implications for Developing Countries', Report 226/00 Energy Sector Management Assistance Programme (ESMAP)/World Bank, Washington, February.

Magnus, E. (1997). 'Competition without privatisation – Norway's reforms in the power sector', *Energy for Sustainable Development*, 3(6), 55–61.

Mohanty, D. (2015) 'Orissa govt cancels licence of 3 Reliance Infra power discoms', *The Indian Express*, 5 May 2015.

Nepal, R. and Jamasb, T. (2011). 'Reforming the Power Sector in Transition: Do Institutions Matter?', Cambridge Working Papers in Economics (CWPE) 1125 & Electricity Policy Research Group Working Paper (EPRG) 1109, Electricity Policy Research Group, Faculty of Economics, University of Cambridge, February.

Nepal, R. and Jamasb, T. (2012). Reforming Small Electricity Systems under Political Instability: The Case of Nepal, *Energy Policy,* Vol. 40, pp. 242-251.

Newbery, D. (2000). *Privatization, Restructuring and Regulation of Network Utilities*, Cambridge, M.A.: MIT Press.

Newbery, D.M. (2013). 'Evolution of the British Electricity Market and the Role of Policy for the Low-Carbon Future', in Sioshansi, F.P (ed) *Evolution of Global Electricity Markets: New paradigms, new challenges, new approaches*, Academic Press, Elsevier.

Newbery, D.M. and Pollitt, M.G. (1997). 'The Restructuring and Privatization of the U.K. Electricity Supply-Was it Worth it?' Public Policy for the Private Sector, Note No. 124, The World Bank, September.

Percebois, J. (2013). 'The French Paradox: Competition, Nuclear Rent, and Price Regulation', in Sioshansi, F.P (ed.) *Evolution of Global Electricity Markets: New paradigms, New Challenges, New Approaches*, Academic Press, Elsevier.

Pollitt, M. G. (2004). 'Electricity Reform in Chile: Lessons for Developing Countries'; CMI Working Paper 51 & Cambridge Working Papers in Economics (CWPE) 0448, Electricity Policy Research Group, Faculty of Economics, University of Cambridge.

Rhys, J. (2013). 'Current German Energy Policy – the "Energiewende": A UK and climate change perspective', Oxford Energy Comment, Oxford Institute for Energy Studies, April.

Riesz, J., Gilmore, J., and Hindsberger, M. (2013). 'Market Design for the Integration of Variable Generation' in Sioshansi, F.P (ed.) *Evolution of Global Electricity Markets: New paradigms, new challenges, new approaches*, Academic Press, Elsevier.

Robinson, D. (2013). 'Living with intermittent renewable power: challenges for Spain and the EU', Oxford Energy Comment, Oxford Institute for Energy Studies, June.

Rutledge, I. (2010). 'UK Energy Policy and Market Fundamentalism: a Historical Overview', in Rutledge, I. and Wright, P. (eds.), *UK Energy Policy and the End of Market Fundamentalism*, Oxford: OIES/OUP.

Rutledge, I. and Wright, P. (eds.) (2010). *UK Energy Policy and the End of Market Fundamentalism*, Oxford: OIES/OUP.

Saran, H. (2014). Role of Trading Companies in Cross-Border Power Trade, South asia Regional Workshop on Competitive Electricity Markets – Design, Implementation and Benefits, ,18-20 March, Colombo, Sri Lanka.

Sen, A.; Nepal, R. and jamasb, T. (2016) 'Reforming Electricity Reforms? Empirical Evidence from Non-OECD Asia', *Oxford Institute for Energy Studies.*

Sen, A. (2016). 'India's Climate and Energy Goals: Contradictory or Complementary?' *Oxford Energy Forum*, May 2016.

Sen, A. (2014) 'Divergent Paths to a Common Goal? An Overview of Challenges to Electricity Sector Reform in Developing versus Developed Countries', EL10, *Oxford Institute for Energy Studies.*

Sen, A and Jamasb, T. (2013). 'Not Seeing the Wood for the Trees? Electricity Market Reform in India' in Sioshansi, F.P (ed.) *Evolution of Global Electricity Markets: New paradigms, new challenges, new approaches*, Academic Press, Elsevier.

Singh, A., Jamasb, T., Nepal, R. ,and Michael Toman. 2015. Cross-Border Electricity Cooperation in South Asia. World Bank Policy Research Working Paper, WPS 7328. World Bank, Washington, DC.

Timilsina, G.R., Toman, M., Karacsonyi, J.G. and de Tena Diego, L .(2015). How Much could South Benefit from Regional Electricity Cooperation and Trade? Policy Research Working Papers WPS7341, The World Bank, Washington D.C.

Tongia, R. (2003) 'The Political Economy of Indian Power Sector Reforms', PESD Working Paper #4, Stanford University.

Toman, M. and Timilsina, G. (2016) 'The Benefits of Expanding Cross-Border Electricity Cooperation and Trade in South Asia', IAEE Energy Forum, Second Quarter 2016.

UKERC (2010). 'Electricity Market Design for a Low Carbon Future', UK Energy Research Centre Working Paper UKERC/WP/ESM/2005/004, October.

Victor, D. and Heller, T.C. (eds.) (2007). *The Political Economy of Power Sector Reform: The Experiences of Five Major Developing Countries*, Cambridge: CUP.

Wijayatunga, P., Chattopadhyay, D. and Fernando, P. (2015). 'Cross Border Power Trading in South Asia: A Techno-Economic Rationale, Asian Development Bank.

Williams, J.H. and Ghanadan, R. (2006). 'Electricity reform in developing and transition countries: a reappraisal', *Energy*, 31, 815–44.

World Bank (2015). Nepal – Power Sector Reform and Sustainable Hydropower Development Project, Project Appraisal Document, Washigton D.C., USA.

Wright, P. (2006). *Gas Prices in the UK: Markets and Insecurity of Supply*, Oxford: OIES/OUP.

Yangki, T. and Tashi, T. (2016). Bhutan Country Presentation, SAARC Dissemination Workshop on Study for Development of Potential Regional Hydro Plant in South Asia, Kathmandu, 09 -10 May, 2016.

Zhang, Y., Kirkpatrick, C., and Parker, D. (2008). 'Electricity Sector Reform in Developing Countries: An Econometric Assessment of the Effects of Privatisation, Competition, and Regulation', CRC Working Paper 31/2002, Institute for Development Policy and Management, University of Manchester.